



## 1. INTRODUCTION

### 1.1 NON-SILICATED MINERAL SPECIES.

If the rocks constituting the earth's crust are generally made more than 95% silicates, the remaining few % are made of minerals so-called “accessories” whose study is sometimes important to explain the rock petrogenesis. These minerals are sometimes of interest very strong economy (precious metals, strategic minerals, diamonds, etc...).

Furthermore, if among igneous or plutonic rocks the varieties exclusively silicates constitute the overwhelming majority, it is not even among sedimentary and metamorphic rocks where rocks carbonates are important, not to mention evaporites, bauxites, phosphate deposits, etc. This is why it is unjustified to go under silence non-silicate mineral species classified as:

- Native elements (metals, semi-metals and metalloids)
- Oxides and hydroxides
- Sulfides and sulfosalts
- Sulfates
- Carbonates
- Phosphates
- Halides.

Without forgetting nitrates and borates as well as chromates, molybdates and tungstates as well as arsenates and vanadates much rarer.

#### 1.1.1 Native elements { العناصر الاصلية }

The term “native” refers to a chemical element, often metallic. which is found in nature in its pure state. There are approximately 80 elements or native alloys. Native elements are quite rare but have great economic importance. We distinguish the native metals (gold, silver, copper), semi-metals (Bi, Sb, As, Te, etc.) and metalloids (carbon, sulfur).

**-Native metals:** Copper, silver, gold, platinum, nickel and exceptionally chrome and iron are sometimes present in the native state. They very rarely appear under form of crystals but rather in the form of chips, sheets, wires, dendrites and sometimes nuggets. Their hardness varies from 2 to 5 and their density, strong, from 8 (Fe) to 21 (Pt). They have a strong metallic shine but not of cleavages and are malleable. They are also good drivers of fluent.

**-Native semi-metals:**

Bismuth, antimony, arsenic, tellurium are semi-metals. Their luster is variable (metallic to submetallic) and their density is high. They are more or less malleable and present cleavages.



### -Native metalloids:

Metalloids (carbon, sulfur) are fragile (except, of course, C diamond), not very dense and have many shapes, such as example carbon, the best known polymorphs of which are graphite and the diamond.

### -Other definition

Native elements or alloys are generally rare, only ones of historical or economic importance are: Gold, copper, silver, sulfur, diamond, graphite and platinum. They are divided into three families: metals, semimetalloids and nonmetals.

### General characters of native elements

Native metals have a strong metallic luster, high densities, they are malleable and do not exhibit cleavage: gold, silver, copper, iron, platinum, for example:

*Semi-metallic elements* have a variable luster, metallic to submetallic; they are more or less malleable and cleavable, dense: bismuth, antimony, arsenic, tellurium, etc.

*Non-metals are represented* by sulfur, diamond and graphite.

### GOLD (Au) Cubic

Rarely in crystals: octahedrons, dodecahedra, sometimes cubes less 1 cm. Generally flakes or irregular grains included in the quartz. In the placers: in dendritic, arborescent nuggets, filamentous. These nuggets are sometimes very important and of a few kilograms.



- D = 19.6; d = 2.5 to 3. Malleable. No cleavage.

- Color: golden yellow to yellow-white (case of varieties rich in silver: electrum). Opaque. Metallic shine. Metallic yellow dust.

-Modes of Deposits: in quartz veins or in deposits detrital (placers). Important deposits: Russia (Urals), Brazil, USA, Mexico, France.

### NATIVE SILVER (Ag) Cubic

Cubic crystals, rare. Most often in compact masses, irregular, dendritic or filamentous. No cleavage, breakage: ductile.





$D = 10.5 / d = 3$ . Opaque, metallic luster, color white, gray, brownish, black patina. White dust.

**Mode of deposit:** in cracks and geodes. Deposits important: Colorado/USA, Broken Hill/Australia, Imiata/Morocco.

**Use:** in metallurgy, in electrical engineering, in industry photographic, for the manufacture of coins, in goldsmithing.

### **NATIVE COPPER, (Cu) Cubic**

Cubic crystals, usually distorted. Most often in masses, compact, in grains, in plates, in filaments.

$D = 8.9 / d = 2.5$ . Malleable and ductile. Scabby breakage.

Color : copper red to brown, copper red on the fresh break. Opaque. Glow metallic. Reddish dust.



### **NATIVE MERCURY (Hg) Hexagonal**

Small tin-white droplets, often covered with a gray film. Solidifies at  $-38.9^{\circ}\text{C}$  in the form of crystals rhombohedral.

$D = 13.5 / d = 0$ . Metallic shine. Very toxic.



**Modes of deposit:** In the alteration zone of mercury deposits. Exploited as an ore with **cinnabar**.

### **NATIVE BISMUTH (Bi) rhombohedral**

Very rare crystals, cubic in appearance. Aggregates generally reticulated, dendritic, also in the form of scattered grains, rarely in large masses.

$D = 9.7; d = 2$ . Perfect cleavage, fragile breakage.

Color: silvery white reddish reflections, multicolored iridescence. Gray line. Opaque, shine metallic.



**Mode of deposit:** in Co-Ni-Ag deposits, sometimes in placers. Important deposits: England, Canada, Bolivia. Locally, important bismuth ore.



### **NATIVE ARSENIC (As) rhombohedral**

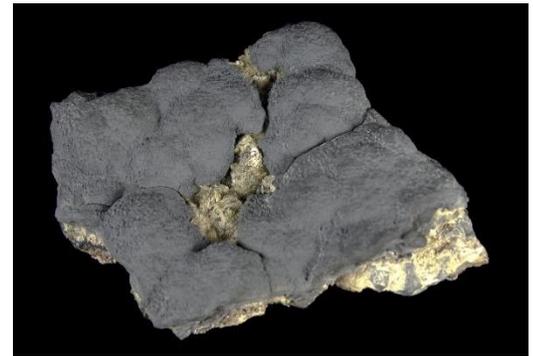
Rhombohedral crystals, cubic in appearance, acicular, rare.

Most often in compact masses, finely granular, in globular aggregates, also stalactiform.

$D = 5.7 / d = 3.5$ . Perfect cleavage.

**Color:** tin white, blackish iridescence, Black dust. Opaque, Metallic luster.

**Modes of deposit:** Accessory component in arsenic ore veins. Important deposits: Germany, Norway, New Jersey. Of little economic importance.



### **DIAMOND (C) cubic**

Usually in crystals: octahedrons or dodecahedrons, more rarely in cubes or tetrahedrons.

$D = 2; d = 10$  (hardest of all minerals). Brittle, fracture conchoidal. Cleavage 111 excellent. Color: colorless or faintly colored in yellow, green, blue, red; brightly colored stones are exceptional and are the most valuable of all gems.

Transparent to opaque. Adamantine luster.



**Deposits:** In kimberlites (ultrabasic rocks filling volcanic explosion chimneys): Kimberley/South Africa; Siberia/Russia. Diamonds, due to their exceptional hardness, resist erosion phenomena and form important detrital deposits (placers): RDC, Brazil, India.

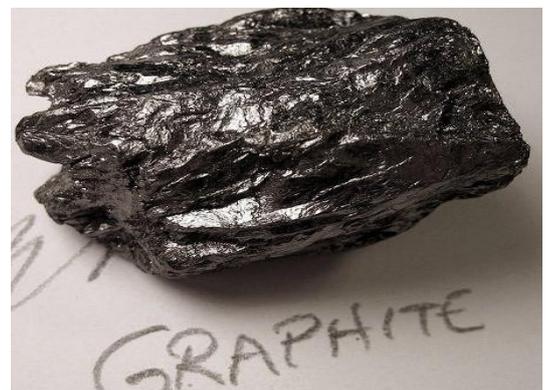
The largest diamond found in Kimberley was the Cullinan, which is a 3106 carat (1 carat = 0.200 g) fragment of a larger crystal.

### **GRAPHITE (C) Hexagonal**

Rare in isolated crystals. Stack of hexagonal lamellae with

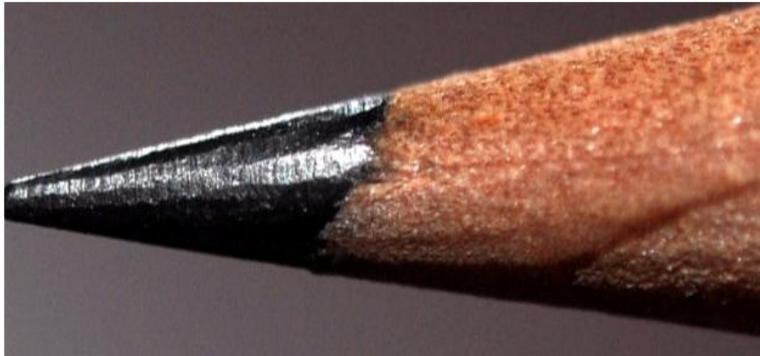
perfect micaceous cleavage. Generally foliaceous masses, rare.

$D = 2.2; H = 1.5$ . Dark gray to black color. Greasy feel, staining fingers, writing on paper. Unalterable.





**Deposits:** Product of general or contact metamorphism of sediments rich in organic matter. Russia (Siberia). U.S.A.



**NATIVE SULPHUR (S) orthorhombic**

Pyramidal crystals, common. Granular to compact aggregates, fibrous, massive, also in the form of crusts, speckles and impregnations.

$D = 2$ ;  $d = 2$ . No cleavage, conchoidal fracture, irregular.

**Colour:** yellow. White dust. Transparent to translucent. Adamantine lustre, resinous, greasy. Burns with a blue flame and a pungent odour.

Mode of deposit: often in volcanic environments, deposited by fumaroles and hot springs, also found in clayey to marly sedimentary rocks. Important deposits: Texas, Louisiana/USA, Iraq, Japan, Indonesia, Sicily/Italy.

**Use:** Raw material for the production of sulfuric acid and important basic substance for the manufacture of pest control products.

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